

RK MANUFACTURING, INC.

Changes Plastics Into Products

GRASSY PAVER™ H-20 (AASHTO)

*Based on the Mississippi Polymer Institute test data performed January 1999, the RK Manufacturing product **GRASSY PAVER™** not only meets but exceeds the AASHTO H-20 standard for vehicular access.*

The American Association of State Highway Transportation Officials (AASHTO) has established an H-20 loading as being a reference of 36,000 pounds. Using these guidelines this weight would be distributed over the front and rear axles of the truck resulting in 20% of the weight on the front axle and the remaining weight, or 80% of the total, realized on the rear. Vehicles of this type usually are supported by two tires in the front and at least four to eight tires in the back on two axles. It is assumed that all tires are equal and that the front tires would be supporting 3,600 pounds and likewise the rear a maximum of 7,200 pounds (four tires) or 3,600 pounds (eight tires).

A field measurement of an H-20 vehicle tire, under load, showed that a footprint of approximately 6 1/2" (wide) x 8" (long) was generated. This footprint produces a planimetric area of approximately 0.36 square feet (sf) over the which the aforementioned tire loads would be distributed. Using a rear tire loading of 7,200 pounds then it can be calculated that an anticipated compressive strength of at least 19,994 psf would be required to support an H-20 loading.

The MPI testing of January 1999 indicates that the compressive strengths of the **GRASSY PAVER™** are considerably higher (76,839 psf unfilled) and thus more than capable of supporting a comparable H-20 loading when installed to manufacturer specifications.

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SUMMARY OF TEST DATA FOR POROUS PAVERS
Testing Performed for RK Manufacturing, Inc. January 1999

Grassy™ Paver (rigid) Compression Testing

Results provided are mean ± standard deviation. Units are lbs / sq. ft.

<u>Fill Conditions</u>	<u>Reduced Temperature (-7° F)</u>	<u>Room Temperature (75° F)</u>	<u>Elevated Temperature (120° F)</u>
Plastic Stress Only (Unfilled)	675,722.9 ± 43,197.3	358,028.9 ± 34,330.1	192,589.5 ± 32,219.3
Full Part Cross Section (Unfilled)	145,022.8 ± 9,271.0	76,839.7 ± 7,367.9	41,333.3 ± 6,914.9
Full Part Cross Section (Soil Filled)	>223,863.5 ¹	79,980.9 ± 5,693.5	65,835.7 ± 1,426.6
Full Part Cross Section (Gravel Filled)	>227,211.5 ¹	146,663.6 ± 17,639.4	103,629.1 ± 13,117.3

1. Load capabilities of MTS-810 were exceeded.

Equiterr™ (Semi-Rigid) Compression Testing

Results provided are mean ± standard deviation. Units are lbs / sq. ft.

<u>Fill Conditions</u>	<u>Reduced Temperature (-7° F)</u>	<u>Room Temperature (75° F)</u>	<u>Elevated Temperature (120° F)</u>
Plastic Stress Only (Unfilled)	349,423.9 ± 11,857.6	151,587.4 ± 4,651.6	76,719.1 ± 3,573.5
Full Part Cross Section (Unfilled)	74,992.9 ± 2,544.9	32,533.5 ± 998.3	16,465.4 ± 766.9
Full Part Cross Section (Soil Filled)	>227,212.7 ¹	67,652.9 ± 15,204.6	48,506.9 ± 18,942.4
Full Part Cross Section (Gravel Filled)	145,274.0 ± 10,950.5	98,303.7 ± 13,440.2	53,998.8 ± 12,081.0

1. Load capabilities of MTS-810 were exceeded.

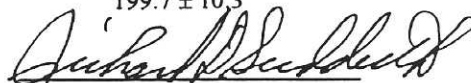
Gardner Impact Testing

Results provided are mean ± standard deviation. Units are in-lbf.

<u>Product</u>	<u>Reduced Temperature (-7° F)</u>	<u>Room Temperature (75° F)</u>	<u>Elevated Temperature (120° F)</u>
Grassy™ Paver	173.0 ± 9.7	135.5 ± 14.2	229.0 ± 18.9
Equiterr™	252.6 ± 8.6	140.4 ± 9.4	199.7 ± 10.3



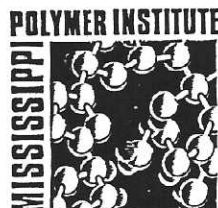
Robert Thompson
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MANUFACTURING EXTENSION CENTER ■ Affiliated with the NIST Manufacturing Extension Partnership

AN EDUCATION ■ INDUSTRY ■ GOVERNMENT PARTNERSHIP



Report for Project No. 0000177

RK Manufacturing

Background for Project

MPI received a number of Equi-Terr Pavers (SR) and Grassy Pavers (R) from RK Manufacturing. Samples suitable for Gardner Impact testing were cut from the material by MPI. These samples were cut from the walls of the hexagonal sections approximately 1/8 inch away from the wall which resulted in 4 extensions. However, these extensions were not in contact with the testing fixture and did not affect the results of the testing. A Gardner Impact Tester LG1120 was used to perform the tests. The variable height method was used and a failure was defined as any crack that penetrated the entire thickness of the sample as could be seen by the naked eye according to ASTM D 5420.

Suitable samples for compression testing were also cut from the material. These samples were cut into honeycomb sections containing 3 cells each with approximately 1/4 inch extensions. The compressive strength property of the materials was measured with a Material Testing System model MTS 810 with an MTS 458.2 Microconsole. An Environmental Chamber model FR-3-CH was used to control the test temperature with an MTS 409.80 Temperature Controller. .

Impact Testing

The first impact test ran was the **room temperature test**. The samples were kept at room temperature for 24 hours before testing. Twenty samples were tested as per ASTM 5420. The Equi-Terr samples had an average thickness of $.111 \pm .003$ inches . The average thickness of the Grassy Paver samples was $.111 \pm .004$ inches . **The average failure energy for the Equi-Terr Paver was 140.4 ± 9.4 in-lbf. The average failure energy for the Grassy Paver was 135.5 ± 14.2 in-lbf .**

The second impact test ran was the **elevated temperature test**. The samples were kept at 120°F for 12 hours before testing. Twenty samples were tested as per ASTM 5420. The Equi-Terr samples had an average thickness of $.111 \pm .003$ inches . The average thickness of the Grassy Paver samples was $.113 \pm .005$ inches . **The average failure energy for the Equi-Terr Paver was 199.7 ± 10.3 in-lbf. The average failure energy for the Grassy Paver was 229.0 ± 18.9 in-lbf .**

The final impact test ran was the **reduced temperature test**. The samples were kept at approximately -5°F for 12 hours before testing. The samples were ran at -5°F due to temperature limitations of the chamber. Twenty samples were tested as per ASTM 5420. The Equi-Terr samples had an average thickness of $.112 \pm .004$ inches . The average thickness of the Grassy Paver samples was $.114 \pm .004$ inches . **The average failure energy for the Equi-Terr Paver was 252.6 ± 8.6 in-lbf. The average failure energy for the Grassy Paver was 173.0 ± 9.7 in-lbf .**

Compression Testing

The compression tests were also ran at three temperatures; room temperature (75°F), elevated temperature (120°F), and reduced temperature (-7°F). In addition, there were three other conditions in which the tests were run; unfilled, gravel filled, and soil filled. The compression tests were ran on 6 samples of each type of material under each condition. Some of the yield strength and ultimate strength results exceeded the capability of the testing equipment. In those cases where the displacement limit is reached a ">D" symbol is noted, and where the pressure limit is reached, a ">P" symbol is noted.

A special jig was fabricated for testing the samples. This jig was designed so that the test samples were held in position by the pegs that extend from the bottom of the samples. The basic design of this jig was a cylinder approximately 8 ½ inches in diameter by 2 inches tall, and was ¾ inches deep. An extension ring was also fabricated in order to fill the sample with soil for compaction. The basic design of the ring was a cylinder approximately 9 inches in diameter by 2 inches tall.

The soil was compacted in the samples using a 5.5 lb X 12 drop ELE International standard compaction hammer model CN-415. This was accomplished by placing the sample in the test jig with the extension ring attached. Then the entire area inside the ring was filled with soil which was compacted once. Then it was refilled with soil and compacted twice. The extension ring was removed and the excess soil was removed and the remaining soil was leveled to the top of the sample and the test jig respectively.

The samples were gravel filled by placing the sample in the test jig with the extension ring attached. Then the entire area inside the ring was filled with gravel. The extension ring was removed and the excess gravel was removed and the remaining gravel was leveled to the top of the sample and the test jig respectively.

The results of the compression tests were calculated using formulas provided by Dr. Sudduth. The area used to calculate the unfilled compression results was .01866 square feet. The area used to calculate the filled compressions results was .08693 square feet. These results are provided below.

Room Temperature

The test results indicated the **unfilled Equi-Terr Paver** had an **average yield strength of 151587.34 ± 4651.6 pounds per square foot** and an **average ultimate strength of 151587.4 ± 4651.6 pounds per square foot**. The **unfilled Grassy Paver** had an **average yield strength of 358028.9 ± 34330.1 pounds per square foot** and an **average ultimate strength of 358028.9 ± 34330.1 pounds per square foot**.

The test results indicated the **gravel filled Equi-Terr Paver** had an **average yield strength of 98303.7 ± 13440.2 pounds per square foot** and an **average ultimate strength of >D 158460.1**

pounds per square foot. The **gravel filled Grassy Paver** had an **average yield strength** of 146663.6 \pm 17639.4 pounds per square foot and an average ultimate strength of >D222043.7 pounds per square foot.

The test results indicated the **soil filled Equi-Terr Paver** had an **average yield strength** of 67652.9 \pm 15204.6 pounds per square foot and an average ultimate strength of >D 86851.2 pounds per square foot. The **soil filled Grassy Paver** had an **average yield strength** of 79980.9 \pm 5693.5 pounds per square foot and an average ultimate strength of >D 159426.7 pounds per square foot.

Elevated Temperature

The test results indicated the **unfilled Equi-Terr Paver** had an **average yield strength** of 76719.1 \pm 3573.5 pounds per square foot and an average ultimate strength of 76719.1 \pm 3573.5 pounds per square foot. The **unfilled Grassy Paver** had an **average yield strength** of 192589.5 \pm 32219.3 pounds per square foot and an average ultimate strength of 192589.5 \pm 32219.3 pounds per square foot.

The test results indicated the **gravel filled Equi-Terr Paver** had an **average yield strength** of 53998.8 \pm 12081.0 pounds per square foot and an average ultimate strength of >D 145122.9 pounds per square foot. The **gravel filled Grassy Paver** had an **average yield strength** of 103629.1 \pm 13117.3 pounds per square foot and an average ultimate strength of >D 168757.5 pounds per square foot..

The test results indicated the **soil filled Equi-Terr Paver** had an **average yield strength** of 48506.9 \pm 18942.4 pounds per square foot and an average ultimate strength of >D 137035.4 pounds per square foot. The **soil filled Grassy Paver** had an **average yield strength** of 65835.7 \pm 1426.6 pounds per square foot and an average ultimate strength of >D 170738.1 pounds per square foot.

Reduced Temperature

The test results indicated the **unfilled Equi-Terr Paver** had an **average yield strength** of 349423.9 \pm 11857.6 pounds per square foot and an average ultimate strength of 349423.9 \pm 11857.6 pounds per square foot. The **unfilled Grassy Paver** had an **average yield strength** of 675722.9 \pm 43197.3 pounds per square foot and an ultimate strength of 675722.9 \pm 43197.3 pounds per square foot.

The test results indicated the **gravel filled Equi-Terr Paver** had an **average yield strength** of 145274.0 \pm 10950.5 pounds per square foot and an average ultimate strength of >D 209489.1 pounds per square foot. The **gravel filled Grassy Paver** had an **average yield strength** of >P 227211.5 pounds per square foot and an ultimate strength of >P 227211.5 pounds per square foot..

The test results indicated the **soil filled Equi-Terr Paver** had an **average yield strength** of >P 227212.7 pounds per square foot and an average ultimate strength of >P 227212.7 pounds per square foot. The **soil filled Grassy Paver** had an **average yield strength** of >P 223863.5 pounds per square foot and an ultimate strength of >P 223863.5 pounds per square foot.